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ABSTRACT

This document contains two studies. The first investigates naturally-occurring aptitude-treatment interactions (ATI) with three teaching approaches--lecture-recitation, inquiry, and public issues discussion. The second study attempts to replicate these ATI in a short-term project. Teachers taught social studies to ninth-grade students according to one of the three teaching methods. Students completed aptitude measures at the beginning of each study and achievement measures at the end of each study. Results indicate that when an experimenter-constructed test was the outcome, the lecture-recitation approach was superior. However, relative effectiveness of the approaches also depends on students' ability and level of conformance. When the measure of the student performance was based on objectives of the approach, the results indicated an ATI for ability x anxiety that was partially replicated across the studies. (Author)

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Technical Report No. 517

Aptitude-Treatment Interaction Effects of Three Teaching Approaches: Lecture-Recitation, Inquiry, and Public Issues Discussion

by Penelope L. Peterson,
Terence C. Janicki, and Susan R. Swing

November 1979

Wisconsin Research and Development
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Penelope L. Peterson, Terence C. Janicki, and Susan R. Swing

Report from the Project on
Studies of Instructional Programming for the Individual Student

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- providing assistance to educators which helps transfer the outcomes of research and development to improved practice in local schools and teacher education institutions

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Abstract

Study 1 investigated naturally occurring aptitude-treatment interactions (ATI) with three teaching approaches--lecture-recitation, inquiry, and public issues discussion. Study 2 attempted to replicate these ATI in a short-term study. Teachers taught social studies to ninth-grade students according to one approach. Students completed aptitude measures at the beginning of each study and achievement measures at the end. Results indicated that when an experimenter-constructed test was the outcome, the lecture-recitation approach was superior. But relative effectiveness of the approaches also depended on students' ability and level of conformance. When the measure of student performance was based on objectives of the approach, the results showed an ATI for ability x anxiety that was partially replicated across studies.

In a recent study of ninth-grade students in introductory social studies, Peterson (1977, 1979) found significant aptitude-treatment interactions (ATI) with four teaching approaches that varied in amount of teacher structuring and student participation. The effectiveness of an approach depended on students' ability, anxiety, and conformance. However, differences between these teaching approaches do not necessarily reflect major differences between existing approaches to teaching social studies in high school. These latter approaches focus on the kinds of thinking students are asked to do in the classroom. For example, Fenton (1967) suggested that teaching approaches may be placed on a continuum with expository teaching at one end and inquiry at the other. Expository teaching emphasizes telling, memorizing, and recalling information, while inquiry teaching involves students gathering knowledge and seeking solutions for themselves. According to this definition, all the approaches in the Peterson (1977, 1979) study were expository approaches.

Oliver and Shaver (1966) have differentiated between recitation and Socratic teaching. Recitation teaching is similar to expository teaching in that the teacher provides the information which the students should know. In Socratic teaching, the teacher has the student take a position on a controversial issue and defend it:

> Here the emphasis is not only on knowledge provided by the teacher as background for the discussion but on the process by

> which the student arrives at a decision about the topic under consideration, on the careful consideration of alternative decisions, and on the utilization of analytic concepts and strategies, regardless of the position that is finally reached. (Oliver & Shaver, 1966, p. 177)

When Oliver and Shaver compared the effectiveness of the recitation and Socratic approaches, they found no significant differences in students' scores on content tests, general reasoning tests, interest tests, and political analysis tests. But they did find significant aptitude-treatment interactions between student personality and teaching approach. Of the 91 ATI for personality that were tested, 12 were significant at the .05 level. A separate analysis showed no ATI for ability. Although Oliver and Shaver took seriously their findings of 12 significant ATI, Cronbach and Snow (1977) concluded that the "12 apparent ATI have to be dismissed as chance results" (p. 407). Oliver and Shaver tested 420 ATI either directly or indirectly; 20 of these would be expected to be significant due to chance. On the other hand, Cronbach and Snow cautioned that the negative evidence of ATI was not definitive because the sample size was inadequate.

The purpose of the present research was to investigate ATI using an inquiry approach, a lecture-recitation approach, a public issues discussion (Socratic) approach, and the aptitudes used by Peterson (1977, 1979). Although Oliver and Shaver (1966) found no ATI for ability, findings from ATI research, in general, have indicated that high ability students do better in approaches which give them greater

freedom to proceed in their own manner (see Cronbach & Snow, 1977). Thus, high ability students might do best in inquiry and Socratic approaches, and low ability students might do best in a recitation approach. However, this effect may be mediated by anxiety as in the Peterson (1977, 1979) research.

The three teaching approaches were also expected to interact with achievement via conformance (Ac) and achievement via independence (Ai). In a study of college students, Domino (1971) found that students low on Ai and high on Ac did better in a conforming approach, which emphasized discipline, attendance, clearly defined homework, and presentation of material through lecture. In contrast, college students high on Ai and low on Ac did better in an independent approach, which did not emphasize discipline, attendance, and homework and did emphasize presentation of material through student discussion. Therefore, students high on Ac and low on Ai might do best in a recitation approach; students low on Ac and high on Ai might do best in inquiry or Socratic approaches.

In the present research, we attempted to maximize external and internal validity of our ATI findings by conducting two types of studies. In Study 1 we explored naturally occurring ATI in a school setting. In Study 2 we attempted to replicate these ATI by experimentally manipulating the teaching approaches.

Method

Study 1

Sample. The subjects were 145 ninth-grade students enrolled in seven social studies classes in an urban Wisconsin high school during spring semester 1978. The classes were taught by three experienced social studies teachers. Each teacher taught his classes according to one of three approaches: lecture-recitation, inquiry, or public issues discussion. Students had experienced all three teaching approaches during fall semester and had elected one for spring semester. The number of students in each approach was as follows: recitation, 40; inquiry, 44; and public issues discussion, 61.

Instrumentation. During spring semester students completed the following aptitude measures: the Verbal Meaning Subtest from the Primary Mental Abilities for Grades 6-9 by Thurstone (1963) [Hoyt reliability (r) = .93]; the State-Trait Anxiety Inventory A-Trait scale developed by Spielberger, Gorsuch, and Lushene (1970) (r = .84); and the Achievement-via-Independence (Ai) scale (r = .48) and the Achievement-via-Conformance (Ac) scale (r = .66) from the California Psychological Inventory (Gough, 1957).

The Verbal Meaning test provided a measure of verbal ability. The standard test directions, which prescribe a 4-minute time limit for the entire test, were altered slightly to make the test more of a power test. The test was administered in two parts of 30 items each. Odd-

numbered items from the original test formed the first subtest while even-numbered items constituted the second subtest. Students had 3 minutes to complete each part. The score was the total correct.

According to the test manual, the Ac scale identifies "those factors of interest and motivation which facilitate achievement in any setting where conformance is a positive behavior" (Gough, 1957, p. 11). The Ai scale identifies "those factors of interest and motivation which facilitate achievement in any setting where autonomy and independence are positive behaviors" (Gough, 1957, p. 11). Seven items were eliminated from the original Ac scale and eight from the Ai scale because they were unnecessarily personal or inappropriate for the students in the sample. Also, the wording of several items was changed slightly to make them understandable to the students. The 20-item anxiety scale purports to measure a general trait or predisposition to experience anxiety.

At the end of the semester, each teacher gave course grades to the students in his class. Grades ranged from A to F.

Procedure

Except for collecting the aptitude information, the classes were taught as usual. Before students completed the aptitude tests, students and their parents were informed of the general nature of the research. They also were told that students were not required to complete the tests. Each student was assigned an identification number by the teacher so that the investigators did not know students' names.

Each class was taught according to one of the three approaches.

Generally, the three approaches differed with regard to instructional objectives and with regard to the roles accorded to the student and teacher in the learning process as reflected in the nature of the classroom activities. In the lecture-recitation approach, the teacher presented a chronological sequence of historical events using lectures, filmstrips, worksheets, and textbooks. It was the students' responsibility to listen, read, or take notes in preparation for objective and essay tests which required the recall of historical facts. Classroom activity in the inquiry approach was characterized by students working individually, researching a historical question using primary source material. Each student used her or his information to arrive at and support a conclusion on a written position paper. The teacher presented information related to writing skills but otherwise served as a resource person. In the public issues approach, students were involved in acquiring and organizing information from primary source material to support a position on a current public issue. Discussion skills--listening, speaking, and oral persuasion--were taught and practiced as students applied their learning in group discussions. The public issues approach has been described in detail by Newman (1970) and Oliver and Shaver (1966).

Study 2

Sample. The subjects were 146 ninth-grade students enrolled in social studies classes in the same high school as in Study 1. The students participated as members of the social studies class they had been assigned to at the beginning of fall semester 1979. Though not

completely random, the investigators expected this assignment procedure to result in classes that did not differ systematically from one another. Six classes taught by two experienced male teachers were involved. All classes had been previously introduced to the lecture-recitation, inquiry, and public issues approaches. Each teacher taught three classes using one of the three approaches. Each teacher's classes were randomly assigned to one of the three approaches. The number of students in each approach were as follows: recitation, 51; inquiry, 41; and public issues discussion, 54.

Instrumentation. At the beginning of the study the following measures were administered: the Verbal Meaning Subtest from the Primary Mental Abilities for Grades 6-9 by Thurstone (1963) [Hoyt reliability (r) = .92]; the Achievement-via-Conformance (Ac) scale (r = .63) and Achievement-via-Independence (Ai) scale (r = .53) from the California Psychological Inventory (Gough, 1957); the State-Trait Anxiety Inventory A-Trait scale by Spielberger et al. (1970) (r = .84); and an attitude toward social studies test (r = .90). The 10-item attitude toward social studies scale was constructed by the experimenters. It had a 5-point Likert response format with the following response alternatives: "strongly agree," "agree," "don't care," "disagree," and "strongly disagree."

At the completion of the 2-week social studies unit, the achievement of all students was assessed by an experimenter-constructed test consisting of 30 multiple choice items (r = .70) and three short essay questions. The test items on the experimenter-made test were drawn

only from the readings and lectures common to all three approaches. The multiple-choice items were designed to assess acquisition of historical facts. The essay questions attempted to measure student ability to integrate and evaluate information. The essay questions were scored in accordance with criteria stressing the factual correctness, clarity, and specificity/generality of the responses. Scores on the multiple-choice test and on the essay questions were treated as separate indices of achievement.

Student achievement within each instructional approach was also assessed using teacher-developed evaluation measures designed to reflect the learning objectives of that particular approach. Student achievement in the lecture-recitation approach was evaluated with a teacher-made 35-item multiple-choice test and an essay question. The multiple-choice items were generated from the readings and lectures, and the essay question tested information conveyed during in-class student reports. In the inquiry approach, the measure of achievement was an essay written in response to an assigned inquiry question requiring the student to support a position on a controversial issue. The essays were scored for content and selected writing skills. A scoring system was established such that a maximum number of points was assigned to each of several scoring categories including essay organization, coherence and correctness of ideas, and number of ideas presented in the argument. In the public issues approach, student preparation for and performance during a small-group discussion provided the achievement measure. The discussion format required the students to present their

views on a number of pertinent topics composing the designated discussion issue. During the discussion, students earned points in accordance with their performance on a number of categories, i.e., use of evidence in support of a position, making a relevant comment, and drawing another person into the discussion. A ceiling was placed on the number of points obtainable in each scoring category. Each student's score was the average of his or her individual score (a composite of preparation and performance scores) and a group performance score.

The same attitude about social studies scale given as a pretest measure was readministered at the end of the study (r = .91). Students also completed a six-item measure of attitude toward teaching approach (r = .90). The latter scale consisted of statements such as, "I didn't like the way my teacher taught social studies." Students responded to the items along a 5-point Likert scale from "strongly agree" to "strongly disagree."

A 20-item version of the experimenter's multiple-choice test (r = .73) and two of the three original essay questions were administered 2 weeks after the completion of the study to assess retention. These multiple-choice items were selected on the basis of an item analysis performed on the original 30-item measure.

Student behavior was observed during class to gather process data to help explain ATI. Each day coders checked the categories of behavior engaged in by two to five students during 18 consecutive 20-second intervals. The observation order was counterbalanced so that each student would be observed at different times during the class period.

The generalizability of the observations was assessed using the

procedure described by Cronbach, Gleser, Nanda, and Rajaratnam (1972). An estimate of the generalizability of the observations across coders and days was obtained by having two pairs of coders code students in each class on several days. One pair coded two days of instruction, and the other pair coded three days. Day was considered to be a fixed effect. The categories for individual students and their generalizability coefficients (ρ) for each pair of coders were as follows: student listening (ρ = .92, .96); student working quietly (ρ = .95, .94); student responding/asking question/commenting (ρ = .71, .71); and student off-task (ρ = .87, .67).

Procedure. Several weeks before the study began, the experimenter met with the teachers to discuss the nature of the study and to assist them in planning a curriculum unit. The unit would simultaneously accommodate the requirements of the study and the teachers' views and priorities as to content, activities, and objectives. A unit on the women's movement was decided upon. The curriculum plan provided for a core selection of readings and activities--three filmstrips and two lectures--to be experienced by students in all three approaches. The content conveyed in these common activities included a survey on important forerunners and leaders in the women's movement, the historical context and chronological sequence of events characterizing the movement, and an introduction to the emergent controversial issues regarding the Equal Rights Amendment. Additional readings and classroom activities were selected to comply with the specifications characteristic of each of the teaching approaches in Study 1. The teachers wrote a

lesson plan for each approach which they followed while teaching the curriculum unit.

Before the study began, parents and students were informed of the general nature of the research. Parents and students were told that students were not required to complete the aptitude tests. One student refused to complete the aptitude tests. He participated in class but was not included in the study.

Two weeks before the study began, the students completed the aptitude tests. During the 2-week unit, each teacher taught each class for 55 minutes per day according to which approach had been randomly assigned. Students were observed and their behavior was coded as described above. Upon completion of the unit, students in each approach were evaluated using the teacher-made measures described above. On a subsequent day student performance was assessed using the experimenter-constructed achievement tests. At this time students also completed the attitude toward social studies scale and attitude toward teaching approach scale. After an interval of 2 weeks, students completed the delayed test. Students did not receive feedback on the correct answers between the immediate and delayed posttests.

Aptitude and outcome measures were computer-scored and item analyses were performed using Fortap (Baker, Note 1). All other statistical analyses were performed with SPSS: Statistical Package for the Social Sciences (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975).

Results

Means and Standard Deviations of Aptitudes

Since students were not randomly assigned to teaching approaches, the means and standard deviations of students' aptitude scores within each study were examined to determine if they were comparable across teaching approaches. These means and standard deviations are presented in Table 1.

In Study 1 aptitude means differed across teaching approaches. On the average, students in the lecture-recitation approach were significantly lower in ability than students in both inquiry ($t_{82} = 1.73$, $p < .10$) and public issues ($t_{99} = 3.04$, $p < .01$). Furthermore, students in the lecture-recitation approach were on the average, significantly more anxious than students in public issues ($t_{99} = 2.31$, $p < .05$). Finally, students in lecture-recitation were significantly lower in their average score on achievement-via-independence than students in inquiry ($t_{82} = 2.18$, $p < .05$). Students did not differ across approaches in their mean scores on achievement-via-conformance. Although it cannot be determined conclusively from the present study, these mean differences in aptitudes between approaches are probably due to self-selection on the part of the students.

In Study 2 the mean scores of aptitudes did not differ significantly across teaching approaches. Apparently the random assignment of classes to teaching approach resulted in groups that were roughly equivalent in aptitude.

Table 1

Means and Standard Deviations of Aptitudes

Aptitude	Study 1			Study 2		
	Lecture-recitation	Inquiry	Public issues	Lecture-recitation	Inquiry	Public issues
Ability						
$\bar{X}$	46.35	50.11	52.23	46.88	46.34	47.41
SD	11.48	8.34	7.99	8.06	9.16	8.77
N	40	44	61	51	41	54
Anxiety						
$\bar{X}$	45.87	43.43	38.51	42.13	38.93	41.39
SD	16.56	15.57	14.99	16.52	16.00	17.09
N	40	44	61	51	41	54
Achievement-via-independence						
$\bar{X}$	11.47	12.95	13.05	11.92	12.32	11.87
SD	3.36	2.87	2.68	3.08	3.33	2.92
N	40	44	61	51	41	54
Achievement-via-conformance						
$\bar{X}$	17.40	18.20	18.49	19.84	18.58	18.98
SD	5.20	4.11	4.13	3.84	4.22	3.58
N	40	44	61	51	41	54

ATI Effects on Approach-Related Measures of Performance

The only student performance measure obtained in Study 1 was the student's semester grade for the course. These grades, given by the teachers, were based on teacher-constructed measures that differed according to the objectives of the teaching approach. Thus, the students' grades given by teachers in Study 1 would be comparable to the students' scores on teacher-constructed measures in Study 2.

Regression analyses were performed on students' grades in Study 1 and on students' scores on the approach-related measures in Study 2. Since students in Study 1 differed in mean aptitude scores between teaching approaches, analyses were performed within each teaching approach. Therefore, it was not possible to examine main effects of teaching approach. The following aptitudes were entered into the equation: ability, anxiety, Ai, Ac, and ability x anxiety. Although Cronbach and Snow (1977) describe a step-up or hierarchical procedure for testing ATI, Cronbach (Note 2) has recommended a simultaneous procedure in which the $\underline{R}^2$ and $\underline{F}$ ratio for a given term is calculated by stepping down from the full regression model to a regression model without that term in the equation.

Table 2 presents the within-treatment regression equations in Studies 1 and 2. The standardized regression coefficients or beta weights are presented so that comparisons can be made between studies. The beta weights for ability and anxiety were further examined by graphing the regression surfaces for the outcome score on ability and anxiety within each teaching approach. The regression surfaces for

Table 2

Within-Treatment Standardized Regression Coefficients for Teacher-Constructed Measures on Aptitudes in Study 1 and Study 2

Study and teaching approach	Beta for ability	Beta for anxiety	Beta for Ai	Beta for Ac	Beta for ability x anxiety
Study 1					
Lecture-recitation	.60***	.01	.00	.18	-.10
Inquiry	.23	.33**	.25*	.41***	-.18
Public issues	.40***	-.12	.16	.28**	.03
Study 2					
Lecture-recitation	.49***	.16	.19	.19	-.15
Inquiry	.32*	.06	.17	.38**	-.12
Public issues	.17	-.06	.03	.07	.30**

Note. Significance is indicated for the test of the null hypothesis Ho:β = 0 using a simultaneous regression procedure.

*p < .10.

**p < .05.

***p < .01.

Study 1 are shown in Figure 1; those for Study 2 are shown in Figure 2.

Several similarities between studies may be noted. First, in both studies the slope of performance on achievement-via-conformance was steepest in inquiry. Second, the slope of performance on ability was steepest in the lecture-recitation approach. Third, there appeared to be an ATI for ability x anxiety. This ATI may be described by comparing Figures 1 and 2. In both studies, high ability students seemed to do equally well in the three approaches regardless of their anxiety level. (See the back surfaces of the cubes.) The performance of low ability students, on the other hand, seemed to depend on their level of anxiety and the teaching approach. (See the front surfaces of the cubes.) Low ability-low anxious students seemed to do well in public issues while low ability-high anxious students did poorly in this approach. Furthermore, low ability-low anxious students did poorly in inquiry, but low ability-high anxious students did well. Similarly, in both studies low ability-low anxious students did poorly in lecture-recitation. However, a difference between studies appeared for low ability-high anxious students in lecture-recitation. In Study 2, low-ability-high anxious students did as well in lecture-recitation as in inquiry. But in Study 1, these same students tended to do poorly in lecture-recitation.

Treatment and ATI Effects on Experimenter-Constructed Measures

Within Study 2 generalized regression analyses were performed on students' scores on the experimenter-constructed measures to test for main effects of teaching approaches and ATI. As suggested by Cronbach

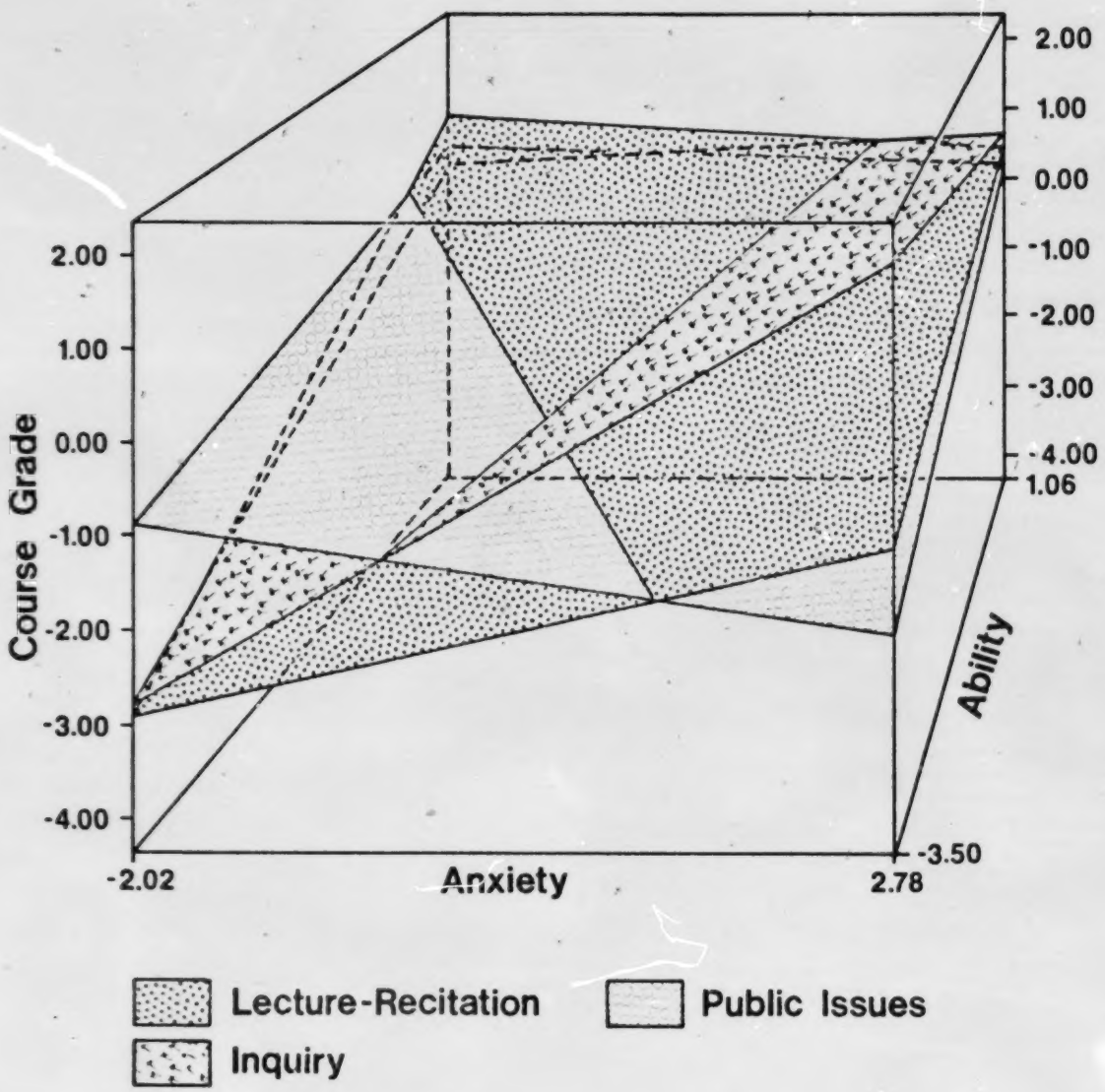

Figure 1. Treatment regression surfaces from regression analyses of course grade on verbal ability and anxiety (Study 1).

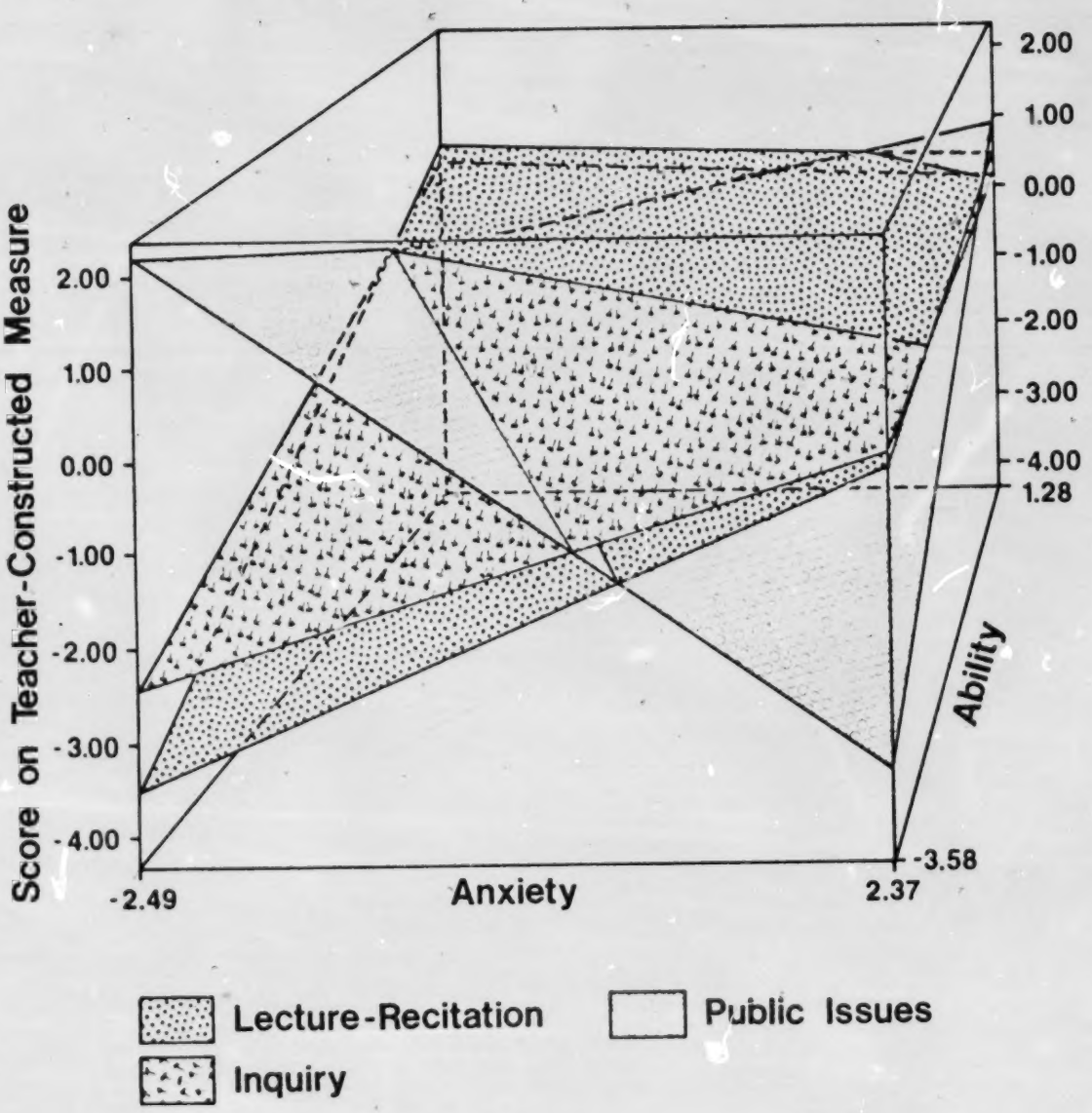

Figure 2. Treatment regression surfaces from regression analyses of teacher-constructed measure on verbal ability and anxiety (Study 2).

and Snow (1977), deviation scores were used for the aptitudes in the regression analyses. Dummy coding (0, 0, 1, etc.) was used for the treatments. Dummy codes were assigned to compare the inquiry and the public issues approaches to the recitation approach.

A simultaneous procedure, as described above, was used here to test aptitudes, treatments, and ATI. Each aptitude or treatment term was tested by stepping down from a regression model, including aptitudes and treatments only, to a model without that term in the equation (see Serlin, Note 3).[1] Each ATI term was tested against the full model.

The numerator of the F ratio was the R^2 due to the variable or group of variables being tested divided by the number of terms being tested. The denominator was 1 minus the proportion of variance predicted by the full model divided by $N - k - 1$ df, where N equals the number of subjects and k equals the number of terms in the full model (e.g., Kerlinger & Pedhazur, 1973, p. 251).

Multiple-choice posttest and delayed test. Table 3 presents the results of the regression analyses on multiple-choice posttest and delayed test scores.

The model, including aptitudes, teacher, and treatments, accounted for 40% of the variance in students' multiple-choice posttest scores. The full model predicted 46.8% of the variance in posttest scores. Ability, anxiety, and Ai contributed significantly to the prediction

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[1] When ATI terms are included in the equation, the b for a given aptitude is the within-group regression coefficient for that aptitude in the group that has been dummy coded as the comparison group. What we wanted to test was the significance of the pooled regression coefficient for the aptitude.

Table 3

Summary of Generalized Regression Analyses on Multiple-Choice Posttest Scores and Multiple-Choice Delayed Test Scores

Variable in regression	df	R^2	F	df	R^2	F
Aptitudes						
Ability (Ab)	1	.153	34.96***	1	.131	33.26***
Anxiety (Anx)	1	.012	2.85*	1	.009	2.34
Achievement-via-independence (Ai)	1	.019	4.42**	1	.012	3.13*
Achievement-via-conformance (Ac)	1	.000	.05	1	.003	.88
Ab x Anx	1	.003	.72	1	.000	.04
Teacher and treatments						
Teacher	1	.009	2.00	1	.001	.17
Inquiry (Inq)	1	.045	10.37***	1	.142	36.21***
Public issues (Pub)	1	.041	9.29***	1	.070	17.83***
Model including aptitudes, teacher and treatments	8	.400	11.43***	8	.461	14.62***
Residual	137	.600	--	137	.539	--
ATIs						
Ab x Inq	1	.019	4.58***	1	.002	.63

Table 3 (continued)

Variable in regression	df	R^2	F	df	R^2	F
Ab x Pub	1	.039	9.37***	1	.023	5.82**
Anx x Inq	1	.000	.08	1	.000	.001
Anx x Pub	1	.001	.24	1	.001	.27
Ai x Inq	1	.002	.52	1	.001	.20
Ai x Pub	1	.000	.04	1	.000	.003
Ac x Inq	1	.025	5.87**	1	.001	.24
Ac x Pub	1	.013	3.07*	1	.001	.36
Ab x Anx x Inq	1	.007	1.63	1	.000	.005
Ab x Anx x Pub	1	.006	1.35	1	.000	.021
Full model	18	.468	6.21***	18	.498	7.01***
Residual	127	.532	--	127	.502	--

*$p < .10$.

**$p < .05$.

***$p < .01$.

equation. In addition, significant ATI and treatment effects appeared. These effects were examined by calculating the within-treatment regression equations from the generalized regression analysis (see, for example, Nie et al., 1975, p. 382). Table 4 shows the unstandardized regression coefficients and the constant within each teaching approach. Figures 3 and 4 present the ATIs for ability and Ac, respectively.

On the average, students in the lecture-recitation approach did significantly better on the multiple-choice posttest than students in either the inquiry or the public issues approaches. However, students' achievement also depended on their levels of ability and conformance. Again, the slope of achievement on ability was steepest in the lecture-recitation approach; the slope of achievement on Ac was steepest in the inquiry approach. Figure 3 may be described as follows: Students high in ability did best on the posttest in the lecture-recitation approach while students low on ability did better in either public issues discussion or inquiry. From Figure 4, it appears that students high on Ac did best on the posttest in the inquiry approach and worst in lecture-recitation. Students low on Ac did best in the recitation approach and worst in inquiry.

The results of the regression analysis on the delayed test scores were similar to those for the multiple-choice posttest except that the $\underline{R}^2$ due to treatments increased and several ATI disappeared (see Table 3). Again, on the average, students in the lecture-recitation approach did significantly better on the delayed test than students in the inquiry or public issues approaches. The only significant ATI was for

Table 4

Regression Equations for Multiple-Choice Posttest and Delayed Test

Dependent variable and teaching approach	Constant	b for verbal ability	b for anxiety	b for Ai	b for Ac	b for ability x anxiety
Multiple-choice posttest						
Lecture-recitation	16.95	.45	-.02	.22	-.29	-.01
Inquiry	14.91	.21	.00	.03	.29	.00
Public issues	15.02	.14	-.04	.17	.09	.00
Multiple-choice delayed test						
Lecture-recitation	12.13	.25	-.02	.08	-.02	.00
Inquiry	8.88	.19	.01	.17	.07	.00
Public issues	10.10	.07	-.03	.09	.07	.00

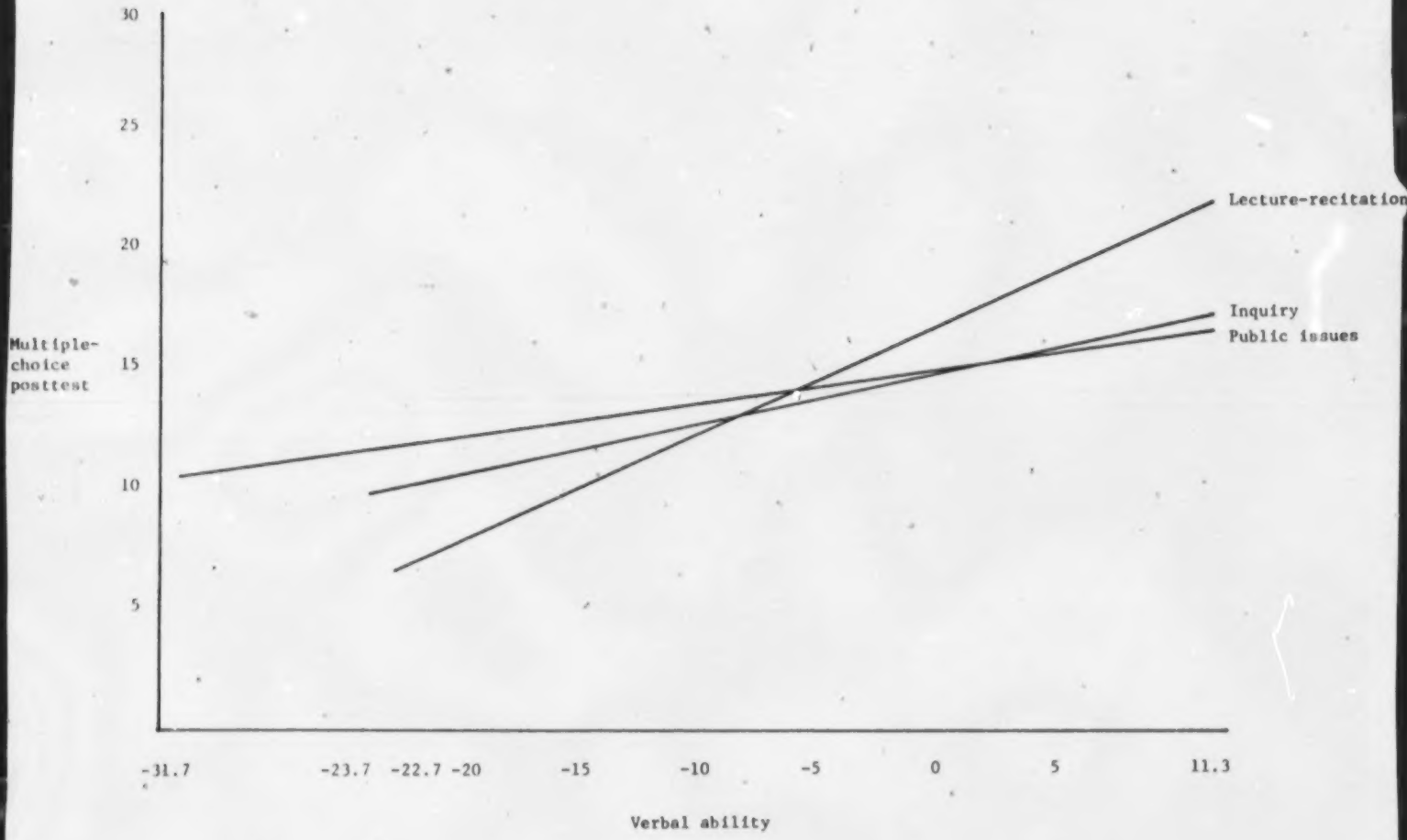

Figure 3. Aptitude-treatment interaction for multiple-choice achievement posttest on verbal ability.

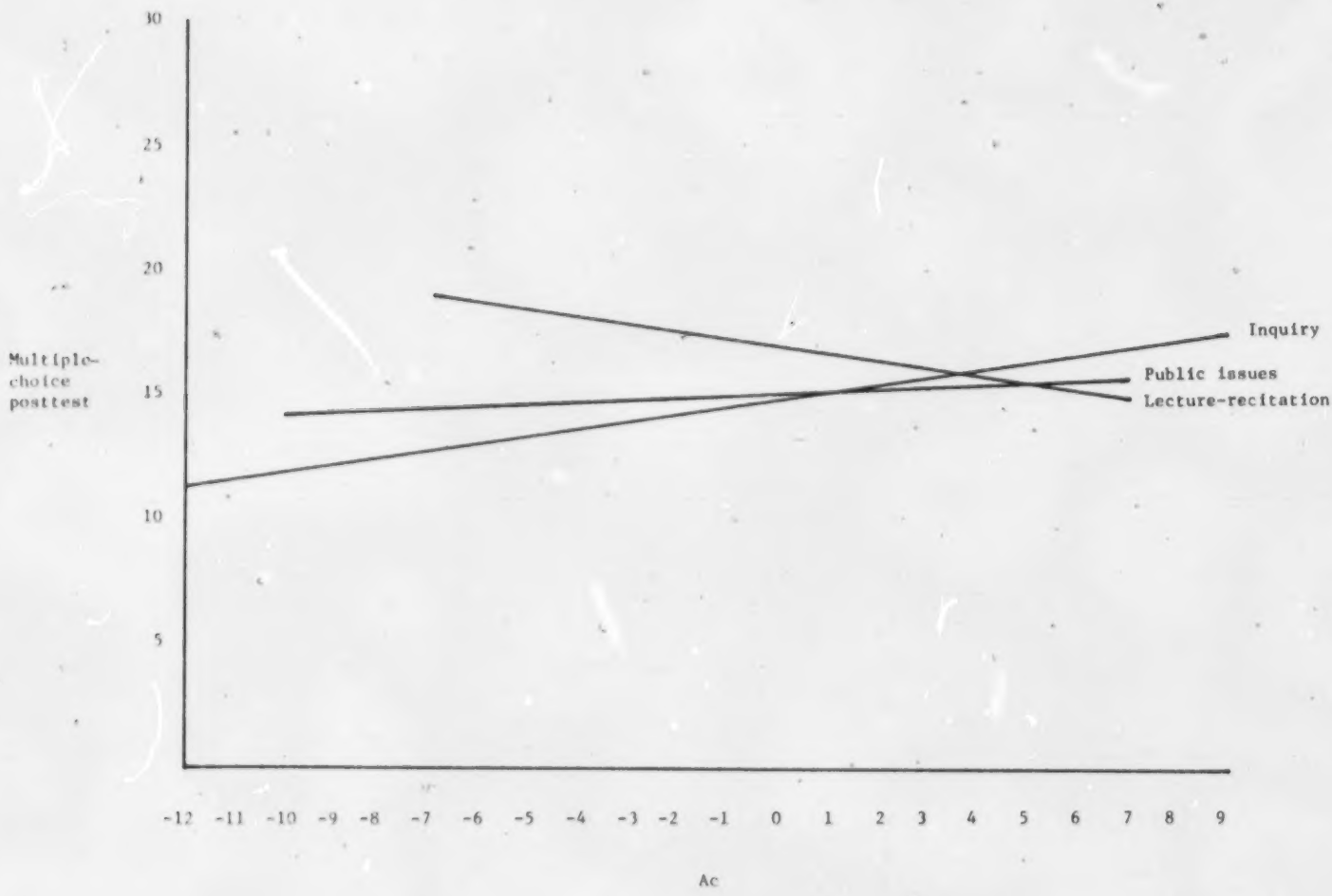

Figure 4. Aptitude-treatment interaction for multiple-choice posttest on achievement-via-conformance (Ac).

ability x public issues. As indicated in Table 4, the slope for ability was steeper in the lecture-recitation approach than in the public issues approach.

Essay posttest and delayed test. Regression analyses on essay posttest scores showed significant main effects for aptitudes and treatments but no significant ATI. For essay posttest, the model including aptitudes, teacher, and treatments accounted for 31.7% of the variance ($F_{8, 137} = 7.62$, $p < .01$), and the full model including ATI accounted for 35.2% of the variance ($F_{18, 127} = 3.83$, $p < .01$). Main effects of aptitudes appeared for ability ($b = .34$; $F_{1, 137} = 13.84$, $p < .01$); Ac ($b = .37$; $F_{1, 137} = 6.11$, $p < .05$) and ability x anxiety ($b = .007$; $F_{1, 137} = 3.80$, $p < .10$). A significant treatment effect appeared for the inquiry vs. lecture-recitation comparison ($F_{1, 137} = 16.08$, $p < .01$). Students in the lecture-recitation approach did better on the essay test than students in the inquiry approach.

In predicting essay scores on the delayed test, the model including aptitudes, teacher, and treatments was statistically significant ($F_{8, 137} = 2.36$, $p < .05$), but the full model was not. The only aptitude that contributed significantly was Ac ($b = .17$; $F_{1, 137} = 3.98$, $p < .05$).

Attitude about social studies and attitude toward teaching approach. Regression analyses were also performed on students' scores on the attitude scales. In addition to the aptitudes described above, students' scores on the attitude pretest were entered into the equation. ATI terms for attitude pretest were also included.

The full regression model predicted 76% of the variance in students' scores on the attitude toward social studies posttest ($F_{21, 129} = 19.33$, $p < .01$). Students' attitudes were best predicted by their scores on the attitude pretest ($F_{1, 141} = 273.90$, $p < .01$). The only other significant main effect for aptitude appeared for anxiety ($b = .04$; $F_{1, 141} = 4.57$, $p < .05$). Teacher and treatments were not significant. The only significant ATI was for ability x anxiety x public issues ($F_{1, 129} = 2.75$, $p < .10$). The unstandardized within-treatment regression coefficients for ability x anxiety were -.009 in lecture-recitation and .008 in public issues. Thus, these regression coefficients were in the same direction as those shown in Table 2 for the regression of performance on ability x anxiety in the lecture-recitation and public issues approaches, respectively. Finally, the full regression model predicted only 13% of the variance in students' scores on the attitude toward teaching approach scale and was not statistically significant.

Relationship of Student Behavior to Aptitudes and Outcomes

To attempt an explanation of the ATI found in Study 2, we examined the observation data. In particular, we were interested in whether student behavior mediated ATI, and, if so, describing those behaviors that mediated ATI. Students' aptitude and outcome scores were correlated with their scores on the four observation variables--listening, working, responding, and off-task.

Results indicated that student behavior did mediate ATI for ability. In lecture-recitation, ability was significantly related to listening

(r = .31, p < .05) and to off-task behavior (r = -.35, p < .05). Both these behaviors were significantly related to achievement on the multiple-choice posttest (r = .30, p < .05 for listening; r = -.26, p < .10 for off-task). In contrast, in the public issues approach, ability was not significantly related to listening (r = .13) or to off-task behavior (r = -.11). These behaviors were unrelated to achievement (r = .17 for listening; r = -.03 for off-task). Similarly, in inquiry, ability was not significantly related to listening (r = .04) or to off-task behavior (r = -.18). Listening was not significantly related to achievement (r = .18), although off-task behavior was (r = -.46, p < 01).

Student behavior also seemed to mediate ATI for Ac. In public issues, students' scores on Ac were unrelated to their behavior during class. However, in the other two approaches significant correlations appeared that showed different patterns. In inquiry, working was positively related to Ac (r = .25, p < .11) and to achievement on the multiple-choice posttest (r = .36, p < .05). But in lecture-recitation, working was unrelated to Ac (r = .01) and negatively related to multiple-choice posttest scores (r = -.24, p < .10). Moreover, in inquiry, responding was negatively related to scores on Ac (r = -.52, p < .01) and on multiple-choice posttest (r = -.46, p < .01). In lecture-recitation, responding was positively related to Ac (r = .31, p < .05) and unrelated to achievement (r = .07). Finally, in both approaches, Ac was negatively related to off-task behavior, and off-task behavior was negatively related to achievement on the multiple-choice posttest.

Discussion

Two major conclusions may be drawn from the results of the present research. First, when an experimenter-constructed multiple-choice achievement test was the outcome, the lecture-recitation approach was superior to the inquiry and public issues discussion approaches. However, the relative effectiveness of the three approaches also depended on individual differences in students. Second, when the measure of student performance was based on the objectives of the teaching approach, a graph of the regression surfaces showed an ATI that was partially replicated across two studies.

Since the primary emphasis in the lecture-recitation approach was on recall on facts and concepts, it is not surprising that when the outcome was a multiple-choice test, the lecture-recitation approach was superior to the other two approaches. As Walker and Schaffarzick (1974) have pointed out, different course emphases produce correspondingly different patterns of achievement. Although this conclusion may seem obvious, "it is comforting to have at least one of our commonsense notions about education confirmed by research" (p. 78).

The results for multiple-choice achievement also showed ATI. The finding that the slope of performance on ability was steepest in the lecture-recitation approach seems to run counter to previous ATI findings for ability as summarized by Cronbach and Snow (1977):

> In nearly all these relationships, we see the highs doing better when given greater freedom to proceed in their own manner, when thrown more upon their own resources. And we see regression slopes becoming flatter when more of the intellectual work is done for the learner (p. 503).

However, if we consider the summary by Snow (1977), the picture becomes more complicated. Snow indicated that research supported the hypotheses that low ability students would do poorly and high ability students would do well when the treatment was described as:

- placing burdens on information processing on learners
- including discovery or inquiry methods
- encouraging learner self-direction (p. 68).

In the present research the inquiry and public issues approaches could be characterized as including inquiry methods and encouraging learner self-direction. Thus, the present results are counter to two of Snow's hypotheses. But the lecture-recitation approach, as implemented in the present study, places more information processing demands on the students than the other approaches and therefore, confirms one of Snow's hypotheses. Students had to listen closely to lectures and take careful notes to achieve in the lecture-recitation approach. Thus, in this approach more than the others, students had to rely on skills such as organizing and memorizing information and taking notes during lecture--skills that are highly related to ability. In support of this argument, the observation data showed that in the lecture-recitation approach, where listening was positively related to

achievement, high ability students listened more than low ability students. In addition, high ability students spent less time off-task in this approach than low ability students, and off-task behavior was negatively related to achievement.

The finding that the slope of performance on Ac was positive in the inquiry approach and negative in the lecture-recitation approach is surprising. We expected more conforming students to do better in lecture-recitation than in inquiry, and less conforming students to do better in inquiry than in lecture-recitation. In fact, the more conforming students did better in inquiry, and less conforming students did better in lecture-recitation.

One possible explanation for this finding is that the inquiry approach, as implemented in Study 2, actually provided more of a conforming situation than the lecture-recitation approach. On the first day of class in the inquiry approach, the teacher gave students a written list of requirements. These requirements included reading and taking notes on several required readings and writing a two- to three-page essay on the assigned inquiry question. The teacher also provided specific guidelines for writing the essay and for taking notes on the readings. In contrast, in the lecture-recitation approach, the teacher did not give a written list of requirements. The teacher merely told students that they should read and study the readings, that they should take notes on the lectures, and that they would be given a test at the end of the unit. The teacher did not provide guidelines for studying or taking notes.

From the observation data, it appears that conforming students picked up on the requirements and acted accordingly in the inquiry approach. Working at one's desk--reading articles and taking notes on articles--was required, and working was found to be positively related to achievement in the inquiry approach. Furthermore, in this approach more conforming students were observed to work more than less conforming students. In contrast, responding--participating in class recitation--was not a requirement in the inquiry approach. Moreover, in inquiry more conforming students tended to do less responding than less conforming students, and responding was negatively related to achievement.

The second major finding was the partial replication of ATI across two studies. Comparison of the treatment regression surfaces in Study 1 and Study 2 indicated that low ability-low anxious students did best in public issues and worst in either inquiry or lecture-recitation. On the other hand, low ability-high anxious students did worst in public issues and best in inquiry. Peterson (1977) suggested that because these students are low on both ability and anxiety they need some external demands to motivate them and facilitate their learning. In public issues discussion, students were called on to participate in class discussions and to take positions on public issues. Thus, low ability-low anxious students would not be able to sit back and do nothing as they might be inclined to do in inquiry or lecture-recitation. In contrast, low ability-high anxious students were already highly motivated so they did not need external demands. In fact, these

external demands probably increased their anxiety and impaired their performance. Furthermore, since these students were low in ability, they would probably be anxious about whether they could do the classwork. Thus, low ability-high anxious students did best in the inquiry approach where they could work at their own pace and obtain help from the teacher as needed.

The replication of an ATI across two studies is important for two reasons. First, it suggests that ATI can be replicated. Many educators have suggested that research on ATI should be abandoned because ATI can not be replicated. (See, for example, Walberg, 1977.) Moreover, Cronbach (1975) himself has pointed out the difficulty of replicating ATI. Thus, the present findings strike a note of optimism for ATI researchers. Second, the present research provides evidence for the generalizability of ATI from a situation where treatments are experimentally manipulated to a situation where treatments are naturally occurring. This suggests that ATI findings can be generalized to the actual school setting and that such findings may have implications for improving school practice.

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